

Litter Tracking App for Patapsco Heritage Greenway

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Introduction

The Patapsco Heritage Greenway (PHG) and the Maryland Department of Natural Resources (DNR) help preserve Maryland's natural resources along the Patapsco River. PHG oversees volunteers who take on various roles ranging from litter cleanup to identification, while DNR works in conjunction with PHG in clean-up efforts. Both PHG and DNR seek to enhance their data collection methods and promote litter clean-up in the communities surrounding the Patapsco River.

This proposed project will create functional wireframes for a mobile application that will allow users to report litter, see litter trends, and identify areas that need attention. The information collected needs to be sorted cleanly and concisely to identify data trends that can help create targeted programs to eliminate litter's primary sources. This document describes the project deliverables and objectives and serves as a formal reference to the data collection, research, and wireframing process.

Methods

To complete this project with a quality deliverable, we first sought to better understand the project scope before planning out our tasks. In the first client meeting we asked targeted questions to narrow the scope into an understandable set of deliverables.

Once we refactored our project scope, we created the project plan using a free online web application, Trello, to create tasks, visualize progress, assign tasks, and organize notes for each task. Although all was going well, we found the full use of Trello required payment. With a limited budget, being unable to access Trello's important paid features quickly hindered our workflow. To mitigate this problem, moved to a similar open-source application called Quire. Quire offered many of Trello's paid options for free and had more impactful graphics to illustrate our progress with the project deliverables.

At mid-semester tasks started approaching fast, and we acted quickly to complete our tasks on time. One of the obstacles we faced was the solidified project team meeting schedules that were built into the project plan. Although we had a structured plan and approach to meetings within our group, we neglected to realize that everyone's availability may not perfectly align with the rigidly designed strategy. Since the deliverables relied on prior tasks, we were pushed off schedule. We shifted task due dates and reorganized to accommodate this mistake, which took time that could have been spent on the deliverables. Quire's easy user interface and the team's flexibility kept us from falling behind.

After completing most project tasks, we finalized the last deliverables by splitting up the remaining tasks to team members who specialized in those topics. For tasks that required group input, such as wireframe brainstorming and design, we met up in group voice calls to provide feedback and to work on design elements. Completed tasks were fitted into the final document to reduce the workload at the end of the semester. This allowed us to include more detail as the tasks were fresh in our minds.

Finally, we reviewed the PowerPoints presentation to ensure that we were delivering the findings in the best way possible. This included transitions and slide design, as well as content, structure, and design. These principles would substantially impact and enhance the client's understanding of the project status and deliverables.

Deliverables

This section describes the project deliverables their value, and how they relate to the project. The actual deliverables are included in separate files (PDF, FIG, PPTX, JSON, XLSX). This report is a brief overview of the project and its findings. Beside each header is the name of the relevant file.

Previous Application Research Document

(d1_application_research.pdf)

The technical analysis of two applications—Literati and Maine Debris Tracker—may help create ideas for features for the Patapsco Heritage Greenway application to ensure it is a competitive choice that users will want to use. Although there are other applications, these two seemed to be the most relevant.

Including previous application research was vital to understanding how successful applications increase engagement and successfully execute their missions. Information from these applications helped identify helpful features that we included in the final iteration of high-fidelity wireframes. Although we did explore these applications for ideas, many were already brainstormed, and others were solely for collecting information about implementation, disregarding the UI structure of other applications. We didn't use protected attributes owned by Literati or Marine Debris Tracker. Finally, the wireframes don't represent a commercial application as users will be able to use the app's features free of charge.



**Marine
Debris Tracker**
Powered by Morgan Stanley


Application Stakeholder Identification and Persona Creation (d2_personas.pdf)

Application stakeholders are critical to identify; they are the people who will use the application. Our research determined three main stakeholders.

- Patapsco Heritage Greenway Volunteers
 - Those who help clean-up litter will be able to use the application to identify hotspots that need attention.
 - Those who help identify litter will be able to use the application to report the location and type of trash.
- Patapsco Heritage Greenway and Maryland Department of Natural Resources Employees
 - Those who oversee volunteer activities will be able to quickly see current cleanup efforts.
 - Those who analyze litter data will be able to see trends in reported data.
 - Those who work with local organizations and policymakers will have data to help develop policies that better protect environmental resources.
- General Public in the Patapsco Region
 - Those members of the public who walks and hike the area can download the application to quickly and easily report litter. They will also be able to connect with others to clean-up trash.

These three stakeholder groups are represented by user personas to better understand a potential user from each group. These personas also help identify additional features to include in the final version of the high-fidelity wireframes. The corresponding document shows a high-resolution version of the personas.

Patapsco Heritage Greenway Volunteer



Goals

- Clean up trash he finds on his walks
- Get more people involved in litter clean up
- Wants to know places to help clean up litter

Frustrations

- Can't pick up single litter objects
- Can't find litter cleanup events on Facebook

Bio

My name is James, and I am a student at the University of Maryland College Park. Since I spend a lot of time on the computer, I often go for walks outside around the local park. During my walks, I often come across litter and trash located along my walking path, and I usually pick it up and bring it back to my apartment building dumpster to keep the local environment clean.


Personality

Introvert ☐ Extrovert ☒
 Analytical ☐ Intuition ☒
 Passive ☐ Active ☒

"We should all work together to protect our natural resources"

Age: 22
 Work: Student
 Family: Single
 Location: Rockville

DNR and PHG Employees



Goals

- Wants to help clean up litter in the environment
- Get more people involved in litter clean up
- Wants to know places that are most impacted by litter

Frustrations

- Can't easily track and identify litter trends
- Finds it hard to get people excited about litter clean up

Bio

My name is Katherine, and I am a DNR employee that works with community outreach and data analytics. I often deal with many litter-reporting and data analytics sources and find it hard to complete the other tasks that I need to complete. I love to create Facebook events and gather community members together to clean up trash.


Personality

Introvert ☐ Extrovert ☒
 Analytical ☐ Intuition ☒
 Passive ☐ Active ☒

"We want to eliminate litter and trash in our environments"

Age: 35
 Work: DNR Employee
 Family: Married
 Location: Baltimore

General Public



Goals

- Wants to get free T-Shirts and Hats for completing tasks
- Enjoys meeting new people
- Seeks opportunities to be outside

Frustrations

- Sometimes it's hard to find events to attend
- Wants to earn rewards for something he already does
- Doesn't like to look at litter around the places he hangs around

Bio

My name is Louis, and I am a recent graduate from California who moved to Ellicott City for my job in Baltimore. Since I just moved out to Maryland, I am looking for ways to meet people outside in the nice weather. I also like to attend events that give out free stuff and enjoy working towards prizes that organizations give out to participants.

Personality

Introvert ☐ Extrovert ☒
 Analytical ☐ Intuition ☒
 Passive ☐ Active ☒

"I love to hangout outside and meet new people"

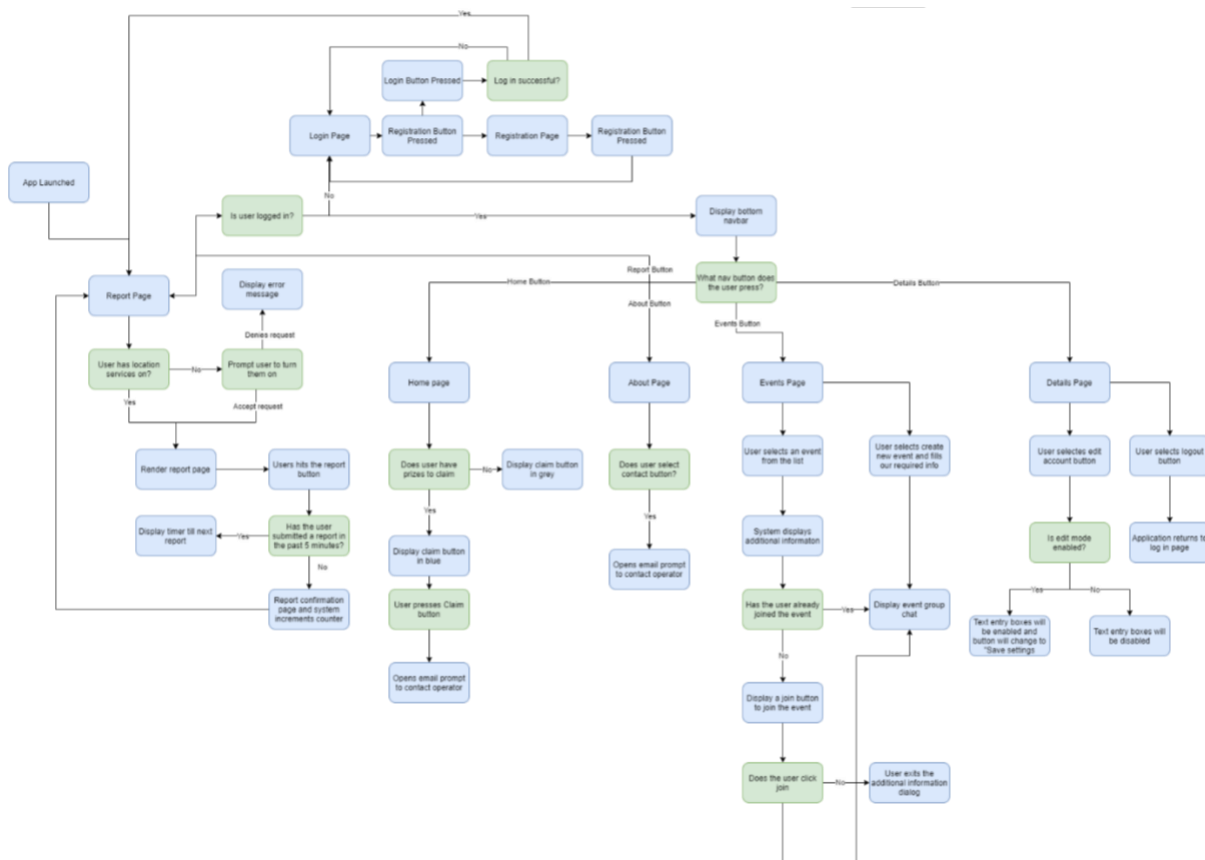
Age: 25
 Work: Accounting
 Family: Single
 Location: Ellicott City

Wireframes and User Flow Diagrams

(d3_wireframe_showcase.pdf, d4_wireframes.fig, d5_user_flow_chart_explanation.pdf, d6_user_flow_charts.png)

The wireframes and user flow diagrams are an integral part of the project. Low-fidelity mockups of the application were shared with the client during a brainstorming session when we crafted more features and design ideas to include in a high-fidelity version of the application. Wireframes allow the client to see what the application would look like, click page elements to understand the application flow, and can be useful in presenting to stakeholders who may want to fund the project. These wireframes were created following Google's Material UI specifications (<http://Material.io>) and their Figma components.

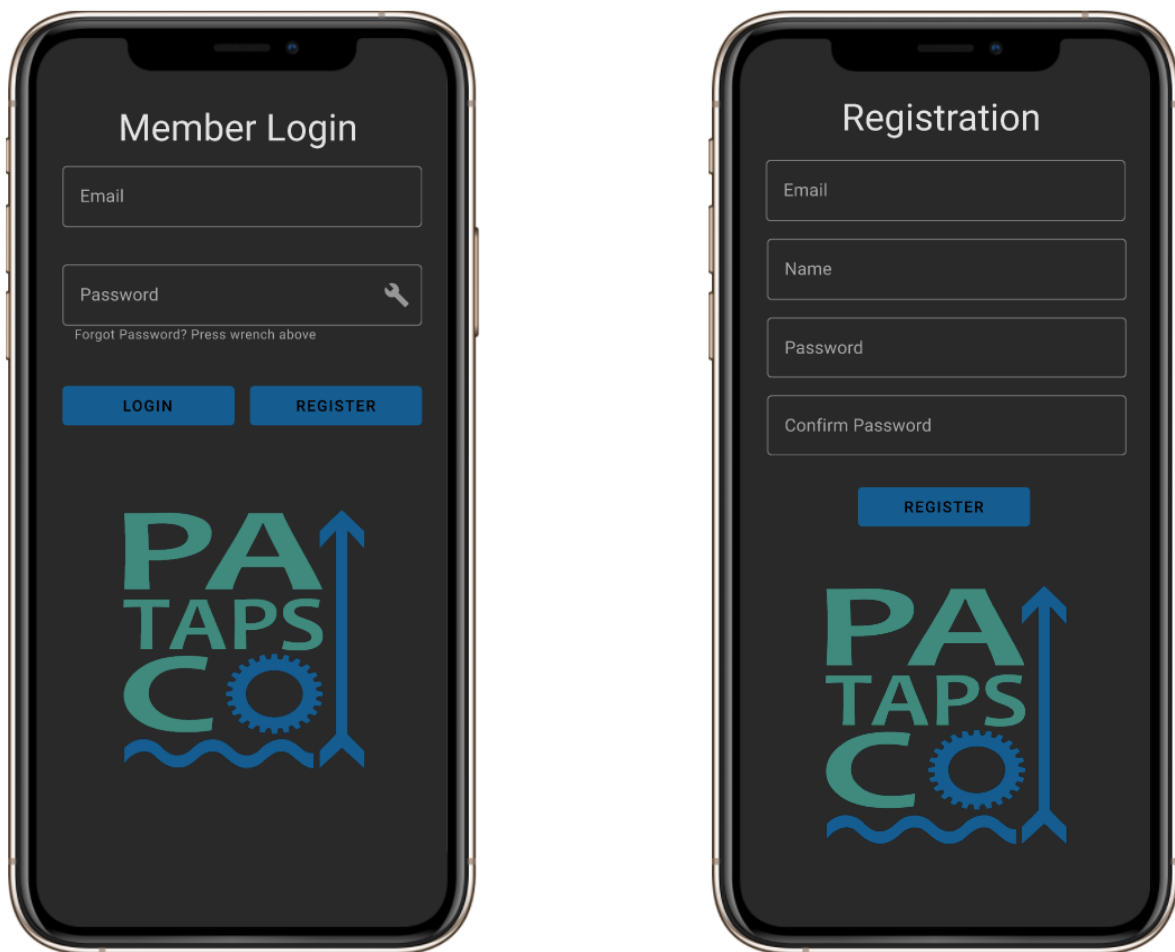
This section covers each page of the application in a high-fidelity wireframe, with an explanation of the page and how it meets the objectives. In addition, user flow diagrams depict how a user will interact with the page. These wireframes and user flow diagrams are included in the final deliverable package as both a PDF document and a Figma figure file.



Full user flow diagram of application

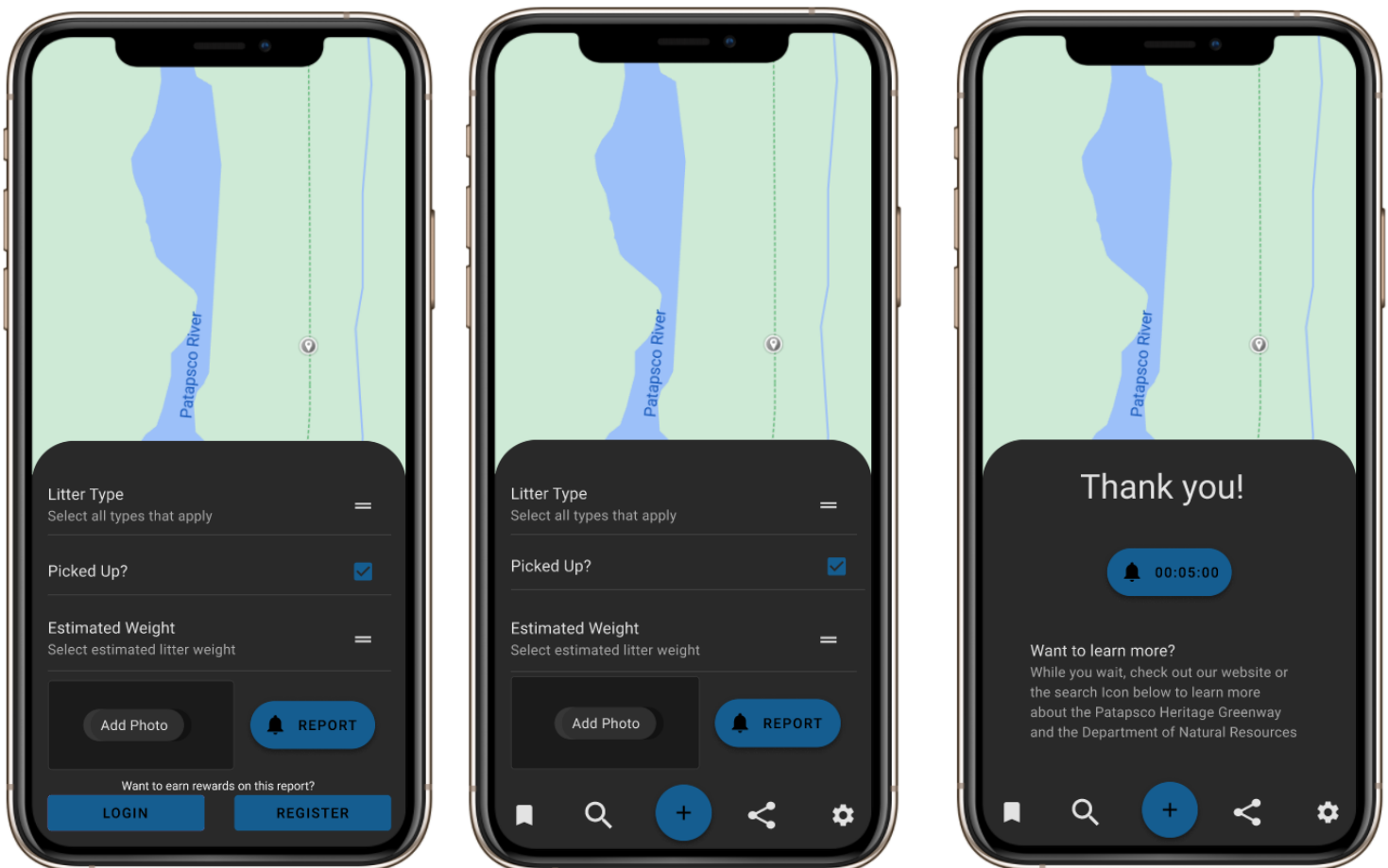
Wireframe 1 – Login and Registration Pages

These two pages are the base functionality for the user account system. They allow users to log in to an existing application or register for an account. Although registration isn't needed to submit a report through the application, a user account is required for most of the application's functionality. Alternative sign-in methods can be implemented such as Google, Apple, and Microsoft and would require the addition of a "Sign in with Google" button directly below the button on the login page.



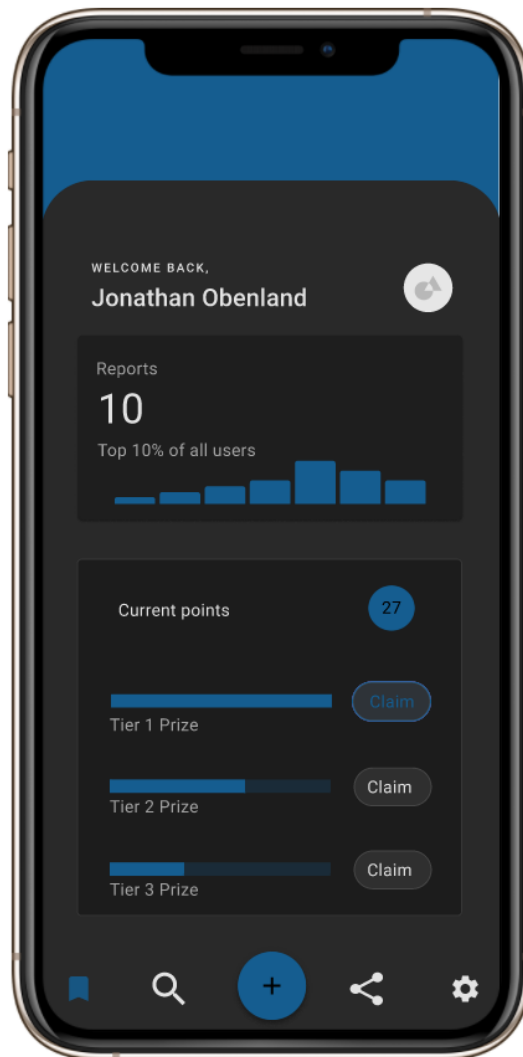
Wireframe 2 – Report Page

The report page is one of the application's critical aspects features; it will be the primary collection method for litter data in the Patapsco region. This report page can exist in three states depending on the user's login status. If the user isn't logged in the application will show the report page but replace the bottom navigation bar with two options allowing the user to either login or register if they have not yet created an account. If a user is logged into the application, the page will show all buttons at the bottom of the page allowing the user to navigate throughout the app. The page's third state appears upon successfully submitting a report. The user will see a five-minute countdown timer until their next report can be submitted. Below the countdown timer, a text divider tells users how to learn more.



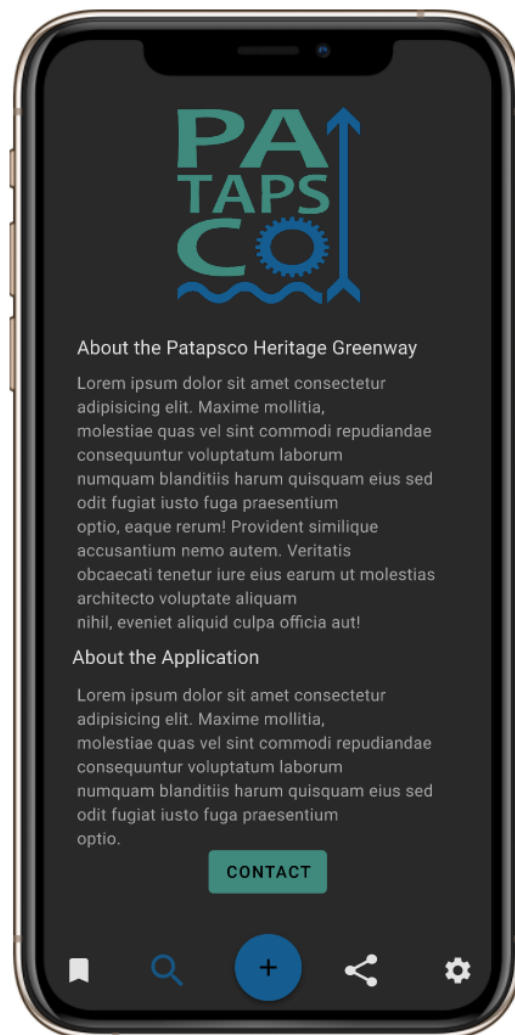
Wireframe 3 – Home Page

The application's home page is the first page the user will see when they launch the application. It includes charts and graphics to show their report progress compared to others signed up for the application. These graphics will help users get more involved to improve their metrics. For every event and report a user interacts with, they accumulate points for prizes. At the bottom of the home page, users can see their progress toward the three point-tiers and prizes. If they meet the requirements, they can claim the prize.



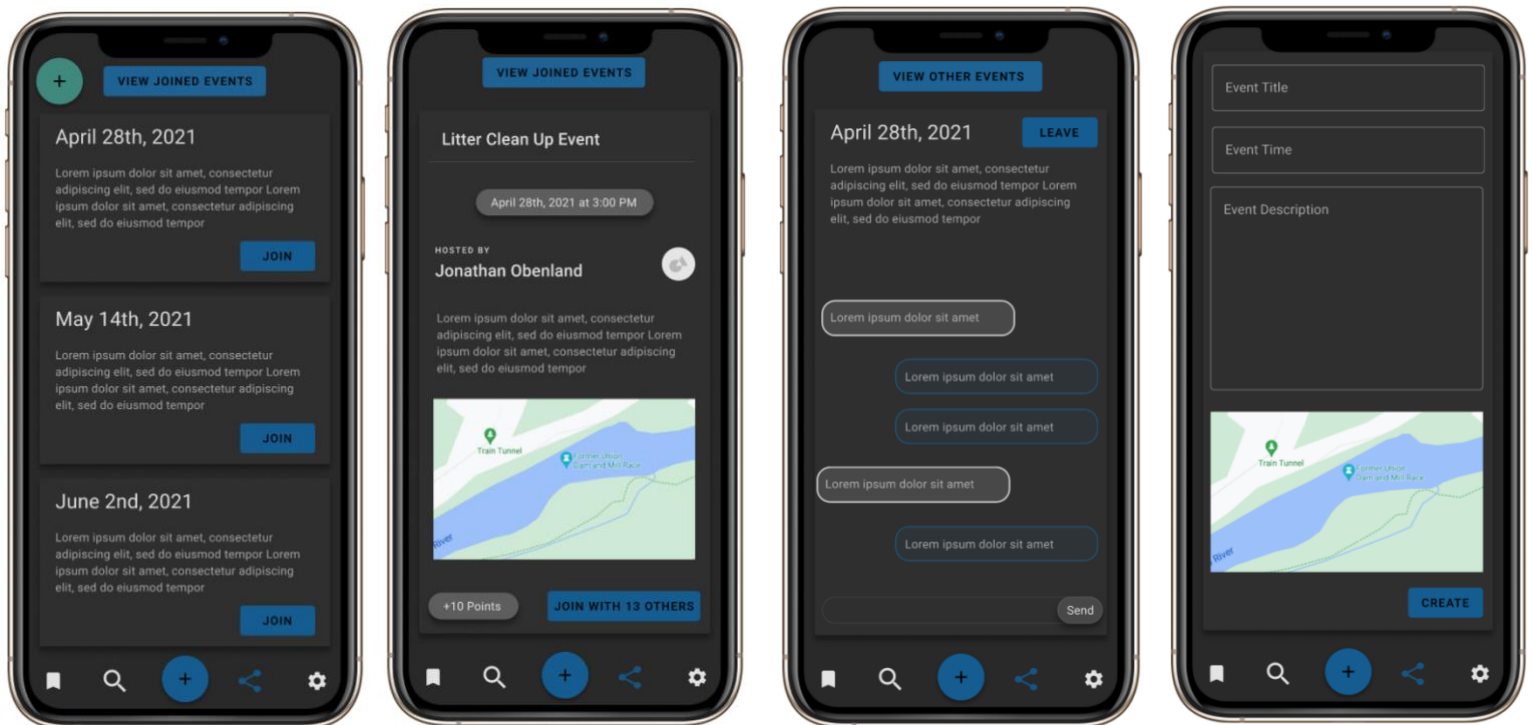
Wireframe 4 – About Page

The about page will give users an understanding of the Patapsco Heritage Greenway’s mission, as well as a description of the application’s purpose. After submitting reports, the application will direct the user to select the explore icon in the navigation bar to learn more about the report they just submitted. This page can also link to the Patapsco Heritage Greenway website for more information. Finally, the page will include a contact button that will allow users to interact with employees of these organizations directly.



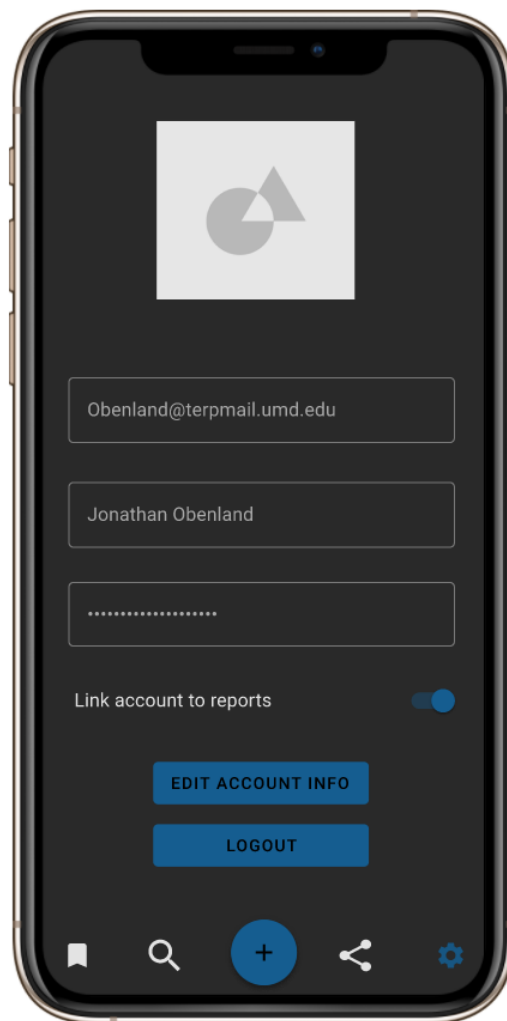
Wireframe 5 – Events Page

The event page will allow users to join, view, and create litter clean-up events in the Patapsco region. During meetings, the client indicated that users often use Facebook groups to organize events and chat with other participants. To enhance the application's usability, we opted to include an in-app text chat feature that allows users to communicate with others about parking, meeting location, and additional important information. Finally, users will be able to create an event and post it to the public board for others to join.



Wireframe 6 – Account Settings Page

The final wireframe is the account settings page, which allows the user to change how their user account interacts with the program. This can change a display name on the home page or the log-in password. This page also includes a privacy option that allows the user to opt-out of linking their username to their reports. Finally, users can select the log-out button located at the bottom of the page to log out of the application.



Data Storage

(d7_data_storage_research.pdf)

Before creating the application, we generated a method and data structure to store the data. The client currently uses Excel to store information about litter, which may not integrate well with the application. Accordingly, we explored different ways to store the information once the application is developed. The full analysis of data storage options can be found in the “data_storage_research.docx” file in the deliverable folder, and the chart below indicates each option’s usability based on maintenance, price, scalability, and usability.

	Spreadsheets	Cloud Hosted DB	Locally Hosted DB	Full IaaS
Maintenance	Low	Low	High	Low
Price	Low	Medium	High	Medium
Scalability	Low	High	Medium	High
Usability	Low	High	High	High

Data Storage Comparison Table

The analysis of data storage solutions showed that a non-relational database hosted on a cloud-based environment would work best with the application. Depending on additional information, a complete IaaS system such as Firebase could host both the front-end application, server, and database. This solution would require the client to pay a small monthly fee to a service provider who would handle the application’s technical aspects, ensure user account security, and ensure 100 percent uptime.

After determining the best data storage method, we developed a data structure for the application to store information about user accounts and generated reports. Data storage in cloud-based environments will be split into two separate collections in the non-relational database. One collection will represent the user accounts signed up for the app, and the other will represent created reports.

email: "Jobenland1@gmail.com"

lastReport: April 8, 2021 at 6:57:45 PM UTC-4

name: "Jonathan"

reports: 43

User Record Snapshot

creation: March 27, 2021 at 8:51:25 PM UTC-4

latitude: 39.00284788476316

longitude: -76.94173847241635

▼ type

0 3

1 4

user: "lJojiyH0echBzoEcwQnDSBC7lWg1"

Report Record Snapshot

Generating and Viewing Sample Data

(d8_sample_data.json, d9_sample_data.xlsx)

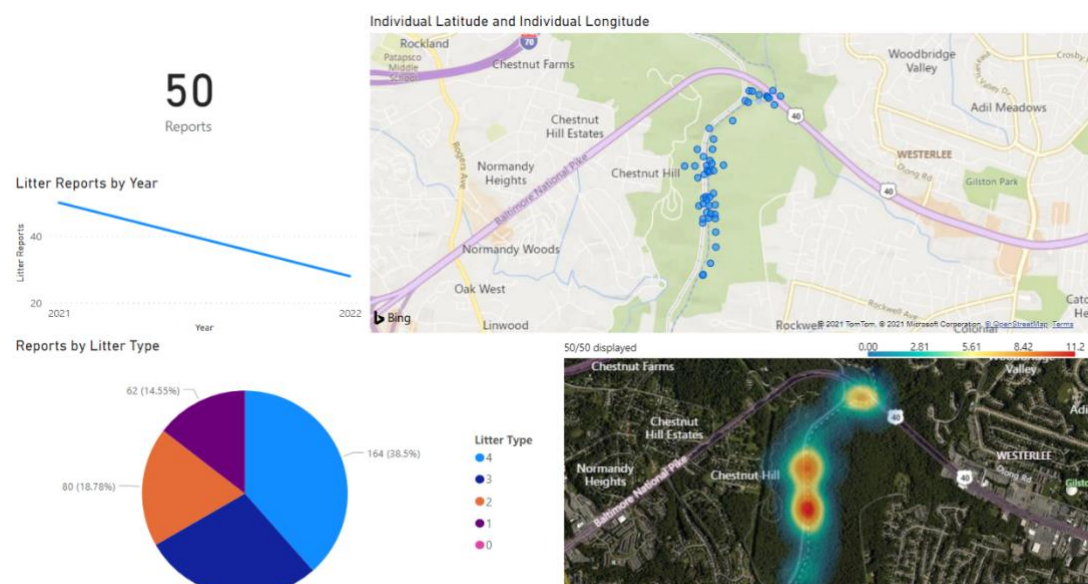
In addition to the wireframes, we generated a mock dataset of 50 data points that looks like actual data exported from the live application. Following the data structure listed in the previous section, we generated the data points and exported them as a .json object to mimic the file type outputted by the actual production application.

```
{
  "creation": "1/1/2021",
  "latitude": 39.28558028840878,
  "longitude": -76.78442459759583,
  "type": [3,4]
},
{
  "creation": "1/1/2021",
  "latitude": 39.28338796785941,
  "longitude": -76.78436022458199,
  "type": [3,4]
},
}
```

Sample Data

We used the mock data to perform a sample analysis to see how users might understand trends within the data. This significant portion of the project would allow the Patapsco Heritage Greenway and Maryland Department of Natural Resources to see areas that need the most help, why litter is more abundant in certain areas, and ultimately craft an environmental policy to address concerns revealed by the data.

To perform the data analysis, we used Microsoft PowerBI to create charts and graphs to view and interact with the data. Although Excel can also create charts and graphics, we felt that PowerBI was more efficient in generating and reading reports.



Sample PowerBI Dashboard

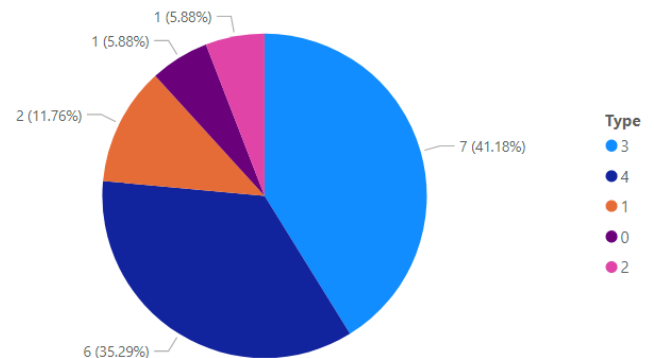
Sample Data Analysis

(d10_powerbi_export.pdf, d11_powerbi_file.pbix)

Once the data was imported, analyzed it to discover trends. We wanted to see the number of reports, the distribution of litter type, and finally, the litter's location. Although future analyses of the data may be beneficial, we felt this analysis best represented the sample data.

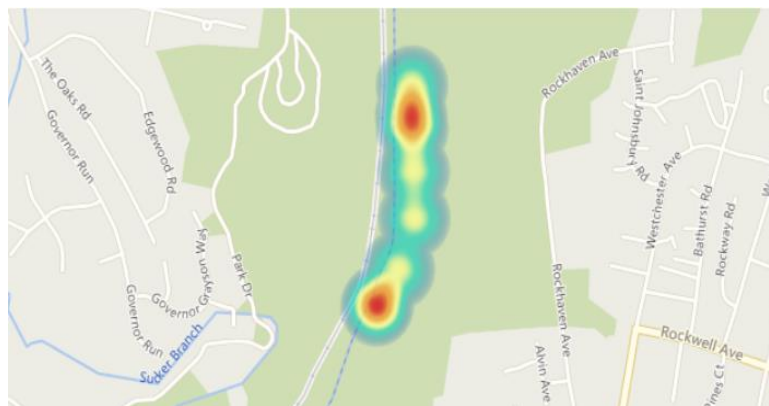
The first part of is recorded in a pie chart that shows the distribution of litter type found in the submitted reports. In most cases, smaller types of litter take up most reports. Still, variations in the types of larger litter may indicate that environmental variables are causing more types of this litter to exist. In that case, a user could click that section of the pie chart and view the hotspots on the map to further explore why these litter types are occurring more often.

Distribution of Litter by Type



We also analyzed the data for hotspots where most of the litter is found. This is an integral part of Patapsco Heritage Greenway's mission—they want to identify areas that need the most attention. As the amount of litter in each area increases, the color becomes progressively redder, indicating a heightened number of reports in that area. With this information, Patapsco Heritage Greenway can target clean-up areas and visit those areas to understand why so more litter is present in those areas. Once they identify the problem causing high amounts of litter, they can work with surrounding organizations to reduce the amount of litter.

Sample Pie Chart



Sample Heatmap

Recommendations

This project lays groundwork for the development, but the application is not yet ready for production. Below are recommendations to complete the litter tracking application project.

To begin the development process, the Patapsco Heritage Greenway should contract a developer team to develop a React-native application using Google Firebase. One team that can build iOS and Android versions simultaneously will save money and time.

Second, we recommend that the developers use the Google Firebase IaaS to decrease the amount of money needed for application maintenance. Google Firebase allows users to easily navigate virtual information systems and analyze application analytics in an easy-to-use interface. Finally, Google Firebase handles the security, maintenance, uptime, and updates needed for an application to stay modern and secure.

We also recommend using automated data pipelines set up by the developers to automatically import data into their software (PowerBI or Excel). This allows the client to view up-to-date information every time they use the application.

Furthermore, we recommend that the client test multiple data visualizations to determine the most beneficial information. Since our data analytics is based on sample data, there may be additional visualizations that would make analyzing actual litter data more efficient.

Conclusions

We want to thank the Patapsco Heritage Greenway and the Maryland Department of Natural Resources for giving us the opportunity to design this application. We would also like to thank the INST490 Instructional Team for helping us succeed in the administrative aspects of this project.

If you have questions about any aspect of the project, please contact our team at Obenland@terpmail.umd.edu or Jobenland1@gmail.com. We will be happy to provide future recommendations as the project evolves and the actual application is created.

